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Czarnek

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(54) **PILL DISPENSING METHOD AND APPARATUS**

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(51) **Int. Cl.**
A61J 7/02 (2006.01)

(52) **U.S. Cl.**
CPC ***A61J 7/02*** (2013.01)

(58) **Field of Classification Search**
CPC A61J 7/02
USPC 221/171, 172, 182, 184, 175, 202, 203
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,777,561	A		1/1957	Rose
3,133,624	A	*	5/1964	Craig 198/443
3,281,012	A		10/1966	Martell
3,386,618	A	*	6/1968	Gilbert 221/12
3,628,694	A		12/1971	Nichols
3,837,139	A		9/1974	Roseberg
5,884,806	A		3/1999	Boyer et al.
8,479,476	B2		7/2013	Baroncini
2006/0219730	A1		10/2006	Handfield et al.
2007/0187422	A1		8/2007	Handfield et al.
2007/0235464	A1		10/2007	Vasquali
2010/0140287	A1		6/2010	Richardson et al.

* cited by examiner

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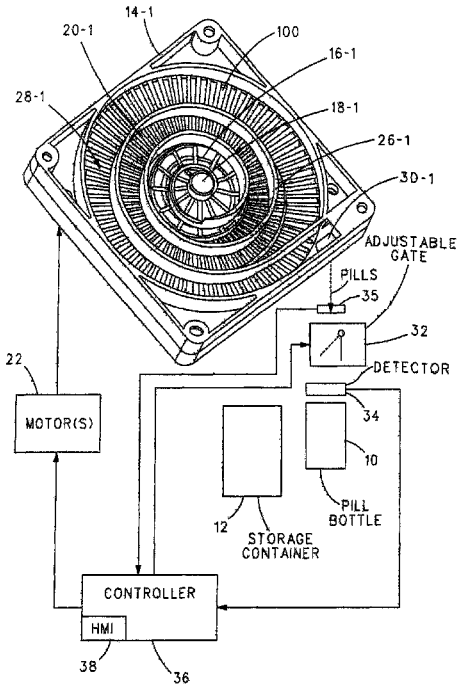
(57) **ABSTRACT**

The present invention is a pill dispensing method and apparatus wherein a first rotor rotates pills about a rotation axis along a first part of a spiral path at a first rotational speed whereupon the pills move spirally away from the rotation axis. A second rotor receives the pills from the first rotor and rotates the pills about the rotation axis along a second part of the spiral path at a second, greater rotational speed whereupon the pills move spirally away from the rotation axis toward a discharge chute which dispenses the pills into a pill bottle or a storage container. A counter can be provided for counting pills that exit the discharge chute or opening.

17 Claims, 9 Drawing Sheets



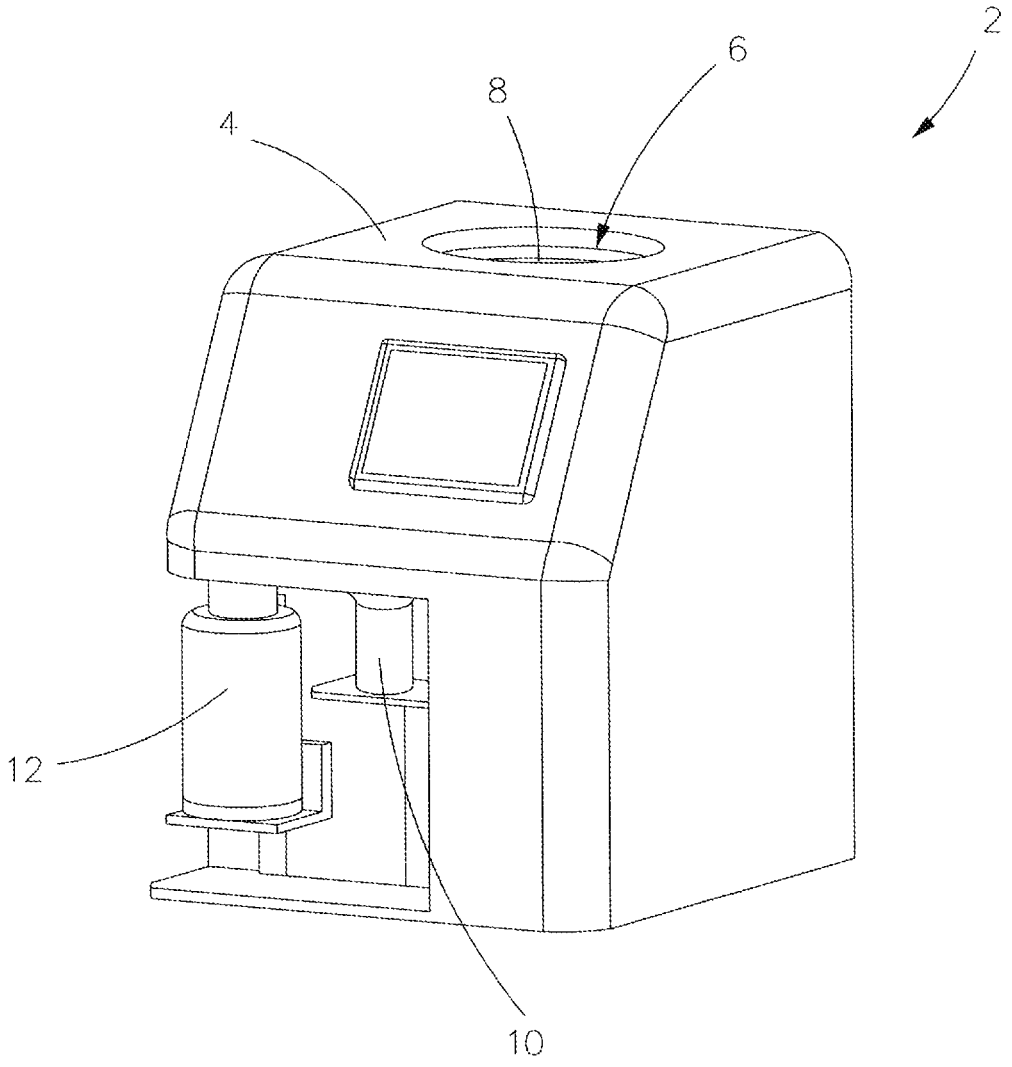


FIG. 1

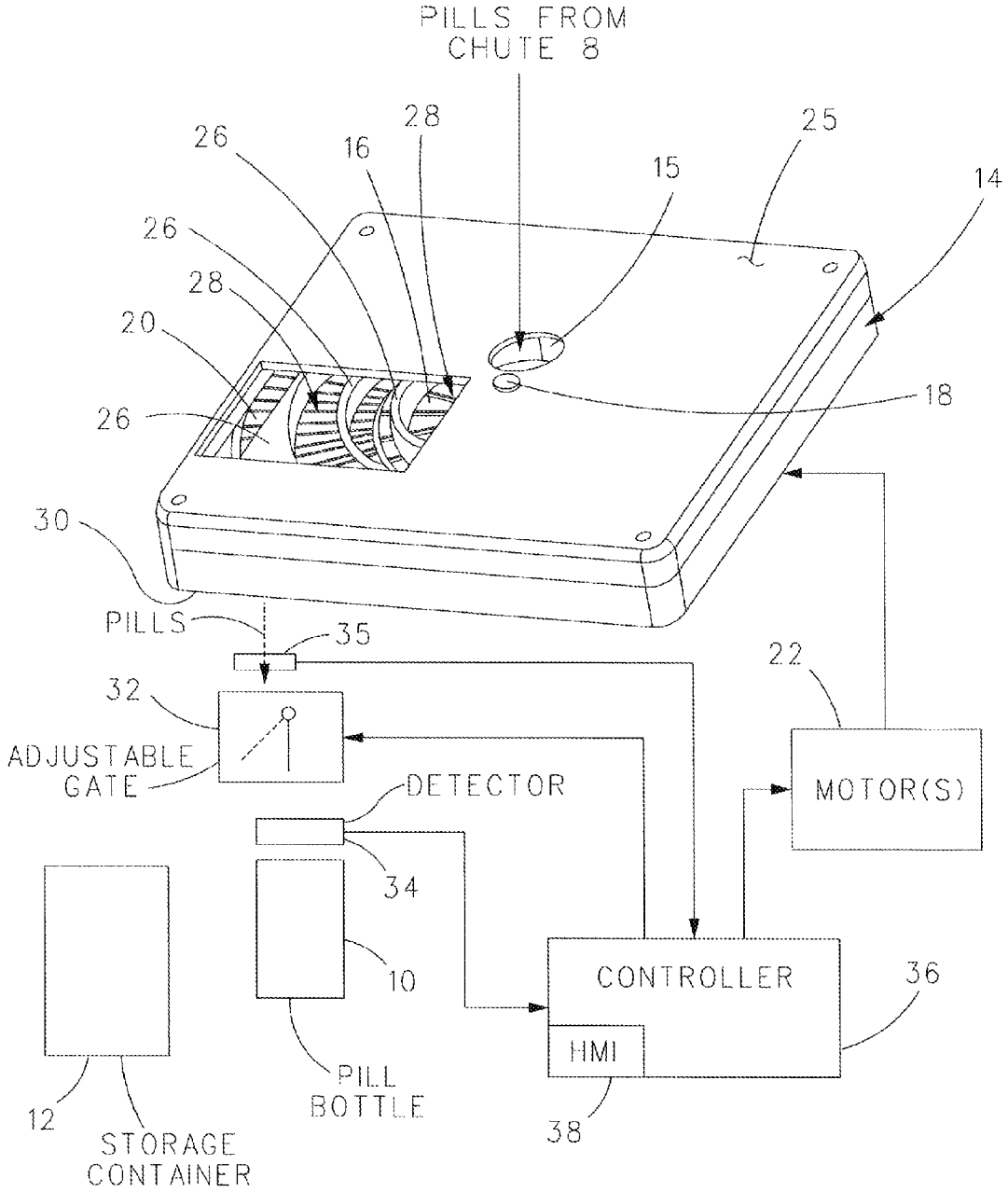

PILLS FROM CHUTE 8
26
16
28
25
15
14
26
28
20
18
26
30
PILLS
35
22
32
ADJUSTABLE GATE
DETECTOR
MOTOR(S)
34
10
CONTROLLER
36
HMI
PILL BOTTLE
12
38
STORAGE CONTAINER

FIG. 2

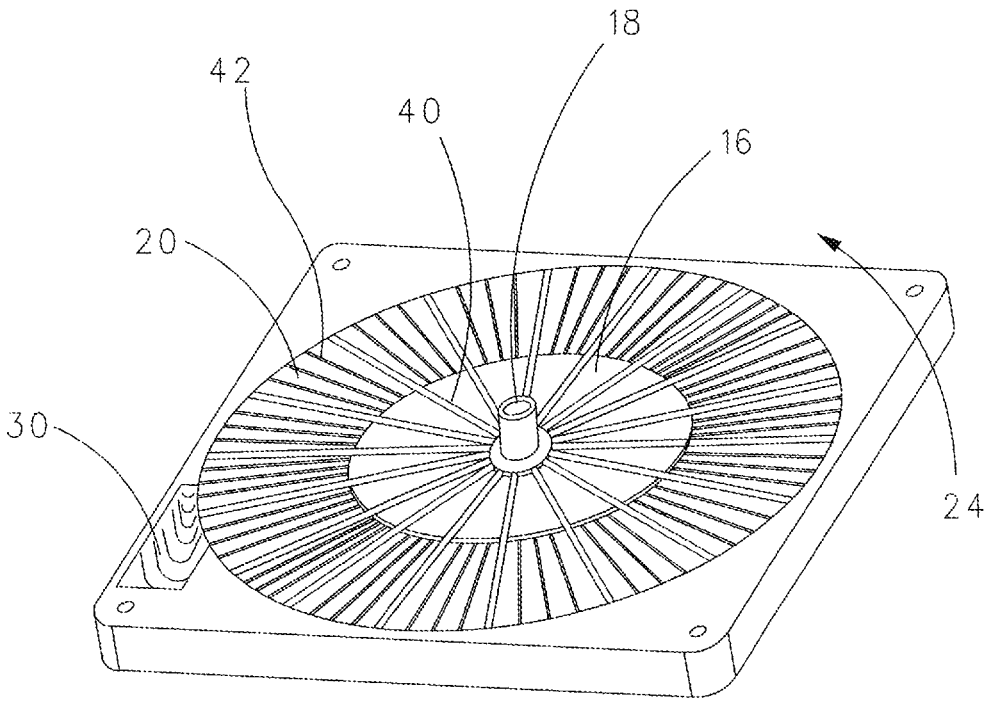


FIG. 3

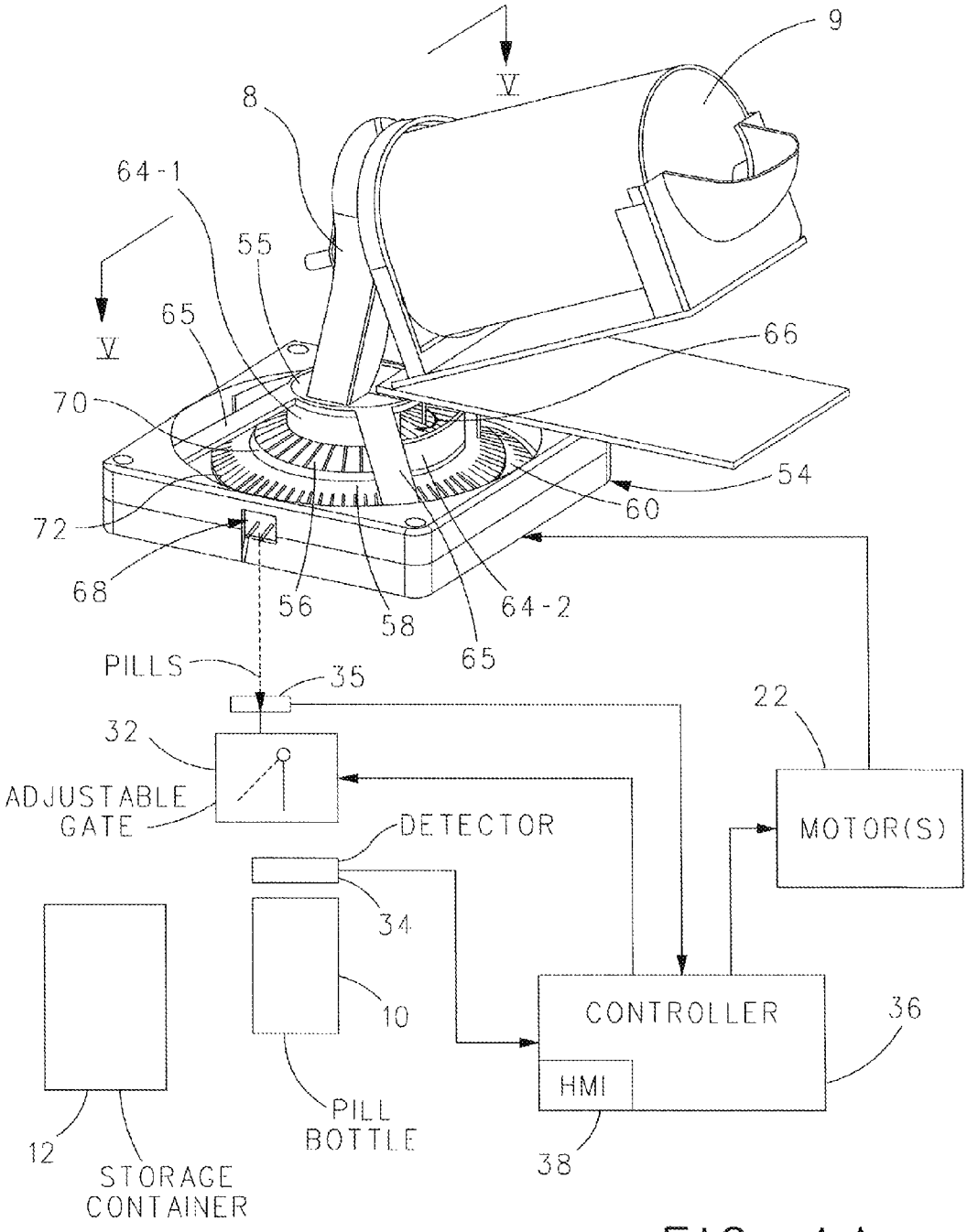

9
V
8
64-1
55
V
65
66
70
54
60
72
68
56
58
64-2
65
PILLS
35
22
32
ADJUSTABLE GATE
DETECTOR
MOTOR(S)
34
10
CONTROLLER
36
HMI
PILL BOTTLE
12
38
STORAGE CONTAINER

FIG. 4A

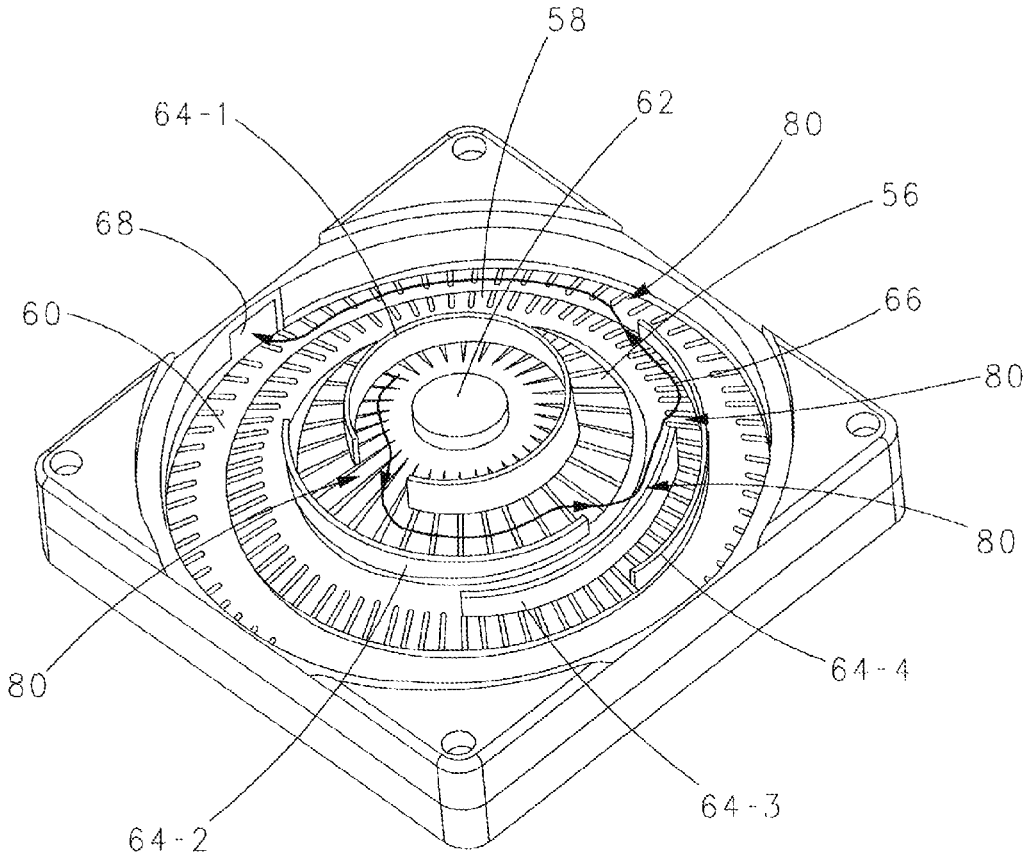


FIG. 4B

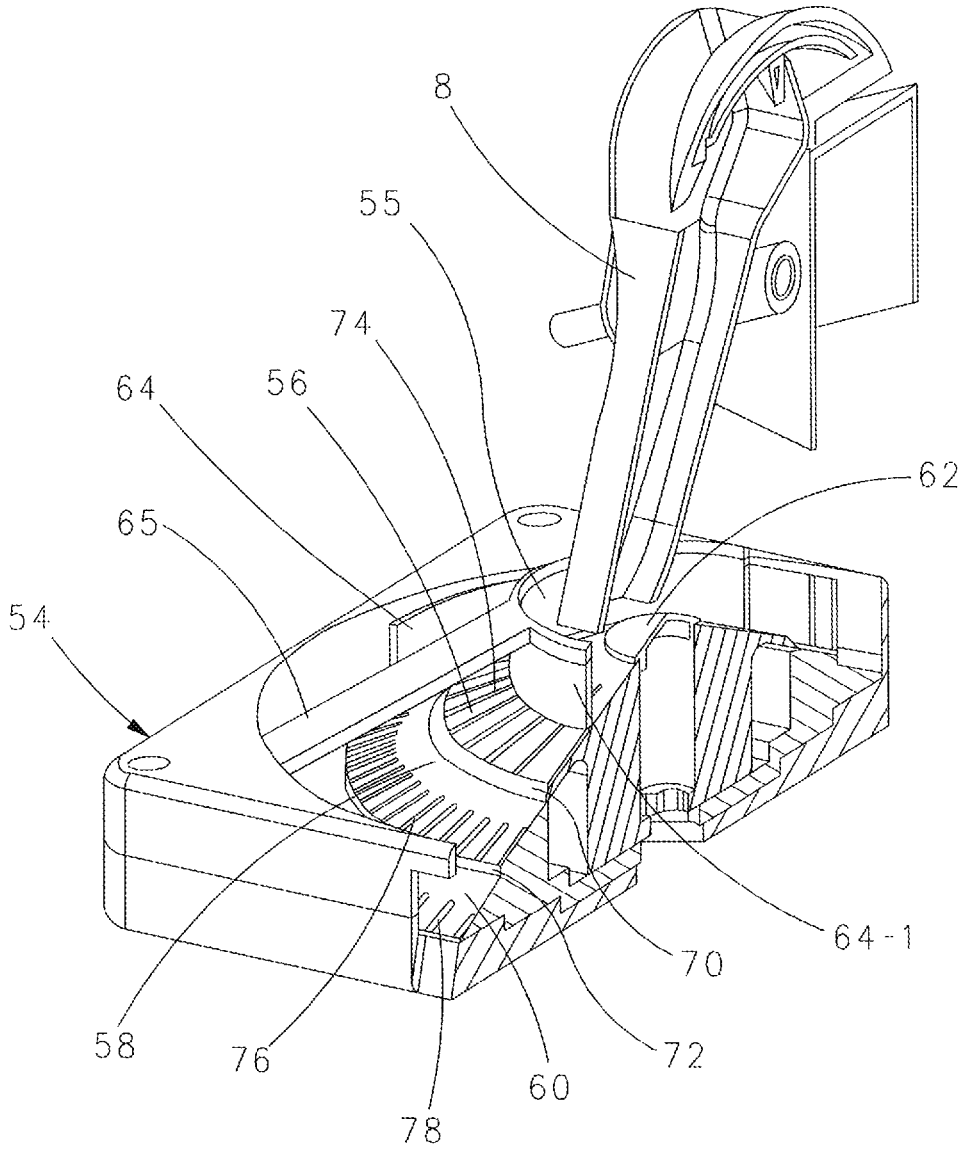


FIG. 5

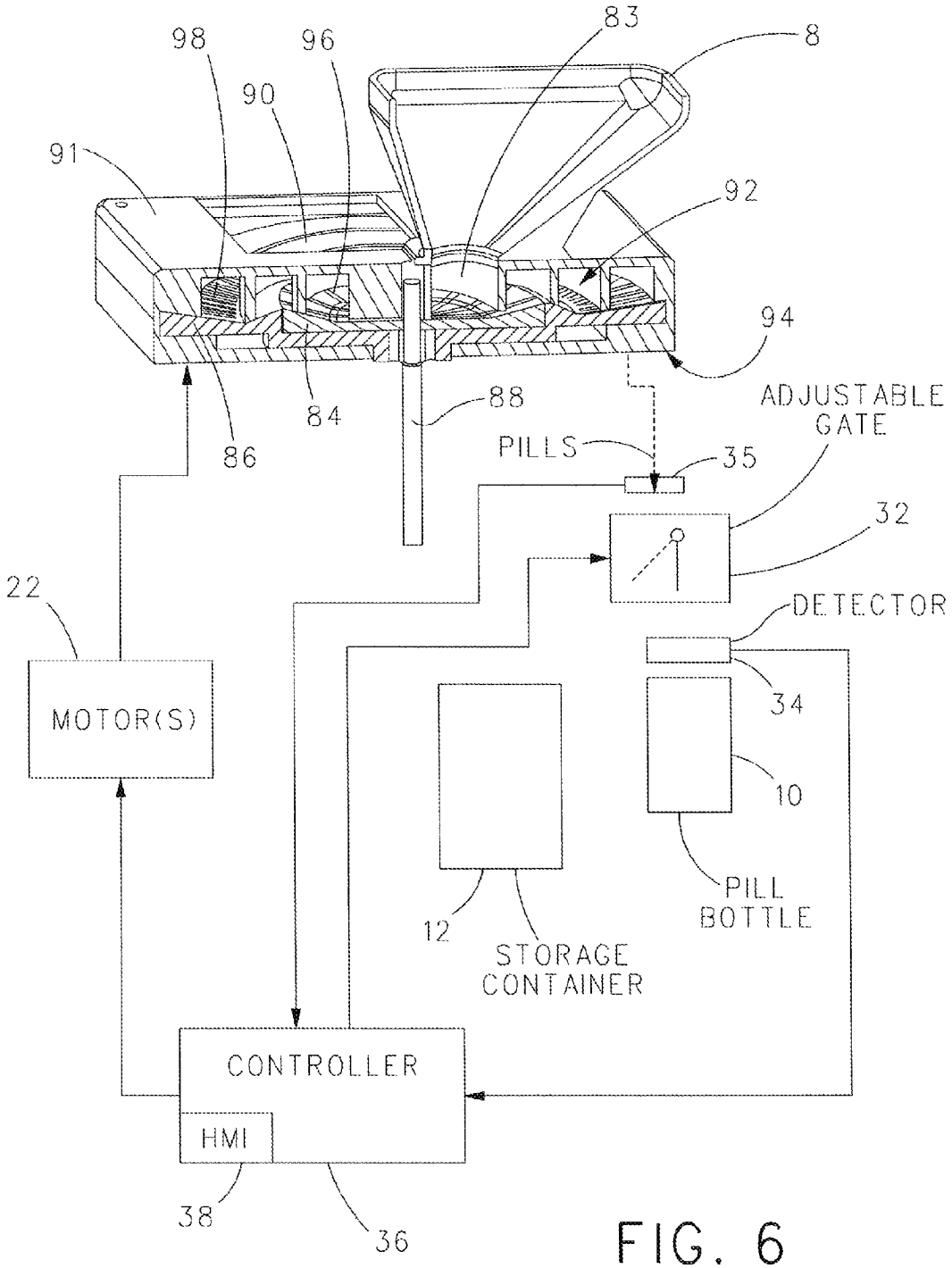
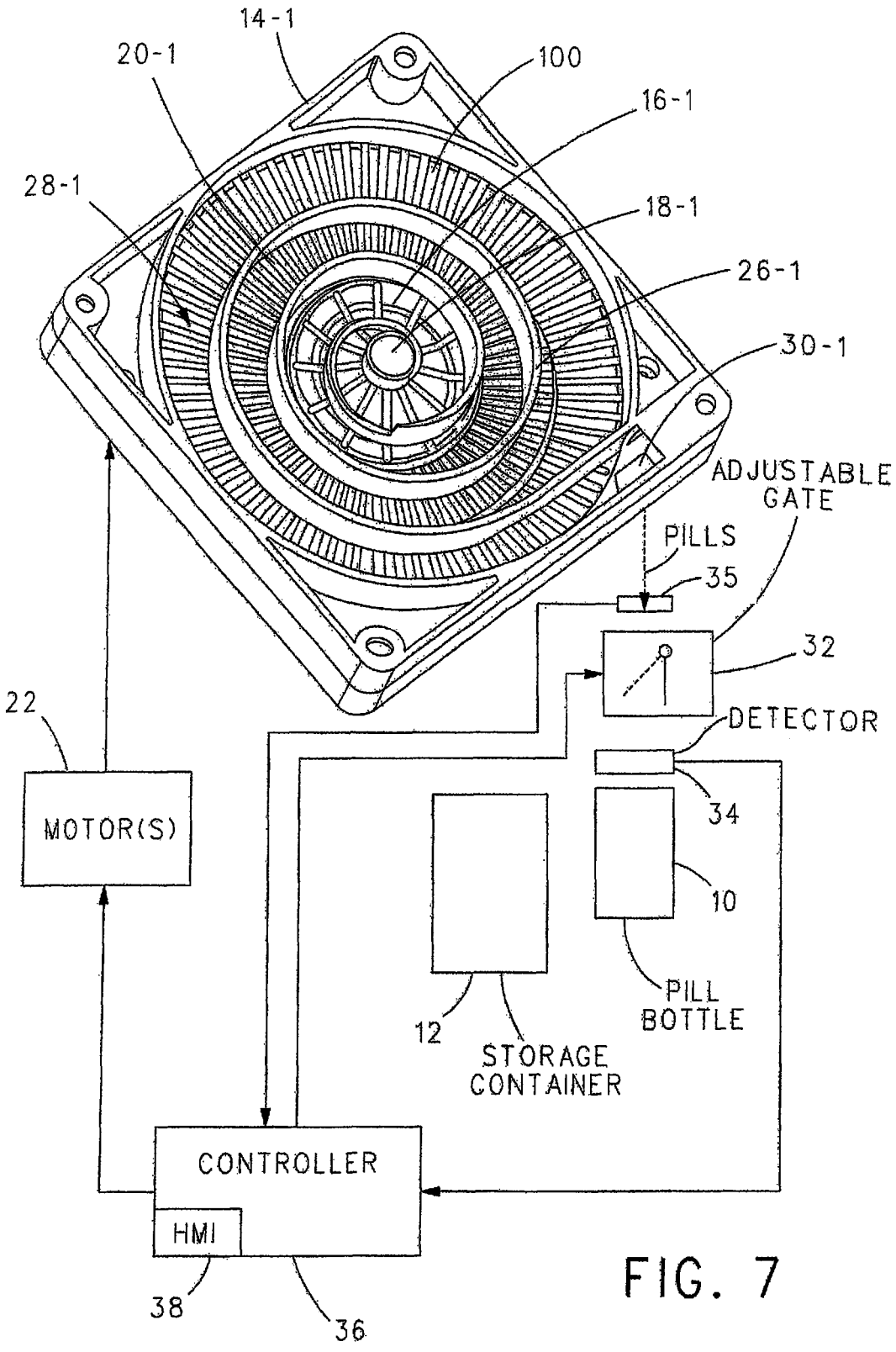

98
96
83
8
90
91
92
94
84
88
86
ADJUSTABLE GATE
PILLS
35
32
22
DETECTOR
MOTOR(S)
34
10
PILL BOTTLE
12
STORAGE CONTAINER
CONTROLLER
HMI
38
36

FIG. 6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20-1
100
16-1
28-1
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26-1
30-1
ADJUSTABLE GATE
PILLS
35
32
22
DETECTOR
MOTOR(S)
34
10
PILL BOTTLE
12
STORAGE CONTAINER
CONTROLLER
HMI
38
36

FIG. 7

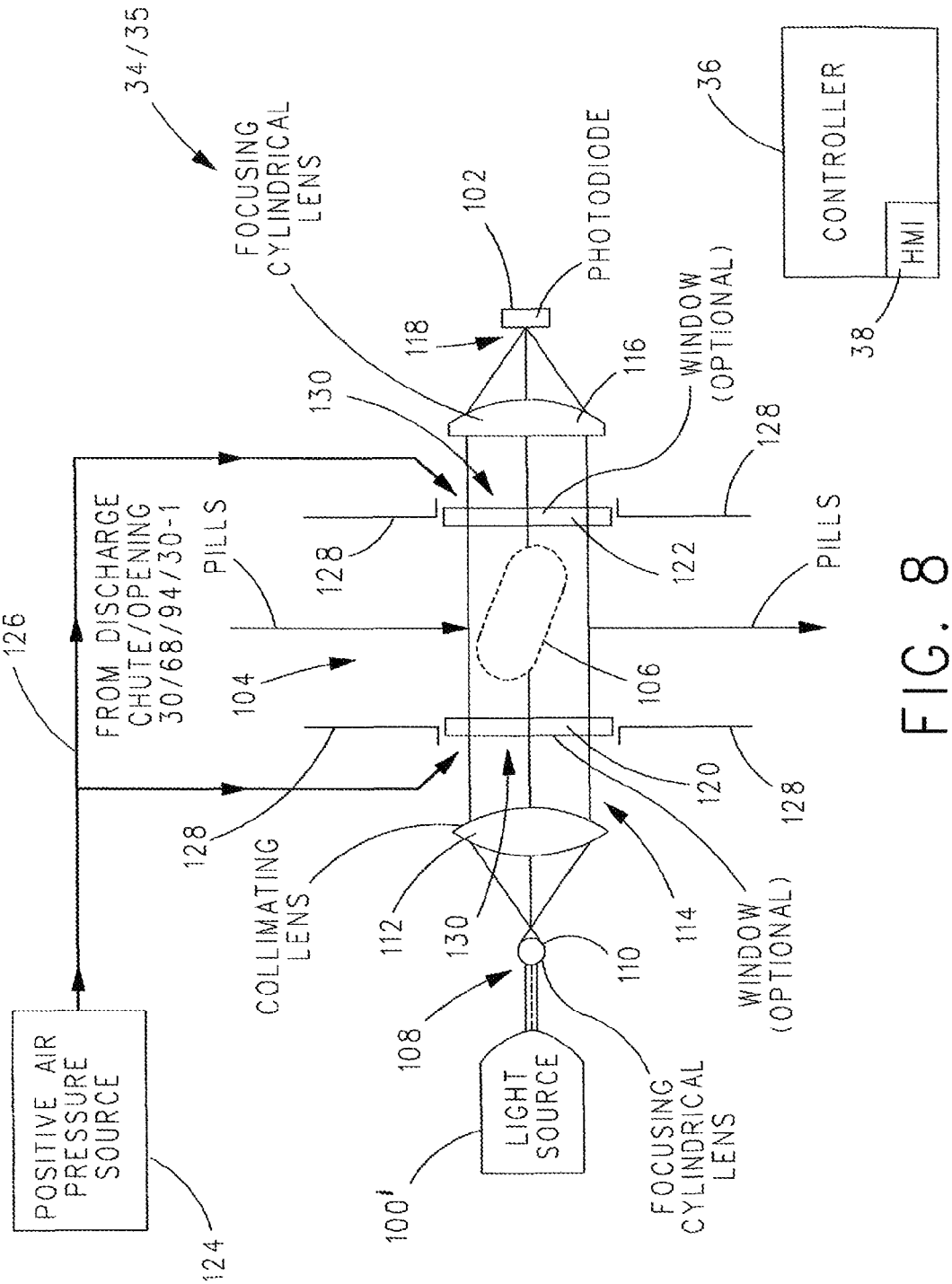
34/35
FOCUSING CYLINDRICAL LENS
102
PHOTODIODE
36
CONTROLLER
HMI
38
118
116
WINDOW (OPTIONAL)
130
128
FROM DISCHARGE CHUTE/OPENING 30/68/94/30-1
PILLS
128
122
PILLS
126
104
106
128
120
128
COLLIMATING LENS
112
130
110
114
WINDOW (OPTIONAL)
108
LIGHT SOURCE
FOCUSING CYLINDRICAL LENS
100'
POSITIVE AIR PRESSURE SOURCE
124

FIG. 8

PILL DISPENSING METHOD AND APPARATUS

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. patent application Ser. No. 13/267,228, filed Oct. 6, 2011, which claims priority from U.S. Provisional Patent Application No. 61/390,275, filed Oct. 6, 2010, both of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

Pharmacists routinely dispense solid medications following doctor's prescription. Most often they count the pills manually with the aid of a counting tray.

In recent years various devices have come to the market intended to automate the counting process and ensure accuracy of the count. Unfortunately all of them either require human involvement in counting, are not accurate or safe enough, or cannot handle certain shapes or colors of the pills effectively.

SUMMARY OF THE INVENTION

A pill dispensing machine includes a hopper or chute into which pills to be counted are poured from a bulk container. A cassette inside the machine includes a plurality of rotors that move the pills along a spiral path. A gate incorporated into the path of pills exiting the cassette facilitates directing the pills either toward a pill bottle or a storage container.

The rotors are desirably concentric disks, curved bowls or cones. Desirably, the pills are fed onto the central rotor via the chute or hopper. However, in applications where a small number of pills need to be handled, a rotor shaped like a bowl can serve the double purpose of a hopper and a mechanism that feeds the outer rotor(s), the latter of which can be shaped like a disk, a bowl or have a sloped or multi-sloped pill receiving surface.

The use of multiple rotors allows controlled rate of feeding and separation of pills reaching a counter into a single line or queue, thereby preventing miscounts. To separate the pills into a single line or queue, the rotors move at different speeds, with the outer rotor(s) rotating faster than inner rotor(s) thereby facilitating the separation. Radial groves, indentations, or protrusions can be provided in one or more of the rotors to avoid pills from rolling and thereby enabling fast and well controlled movement of pills.

Once the desired number of pills is dispensed into a pill bottle, any remaining pills in the cassette can be returned to the storage container by increasing the speed of the inner rotor(s). Having the outer rotor(s) rotating faster than the inner rotor(s) facilitates separating pills in a single line or queue. However, this approach slows down the feed of the pills when one wants to return remaining pills to the storage container. If the rotors are powered by a single motor through a set of fixed gears, then the speed at which remaining pills can be returned to the storage container is limited by the maximum allowable speed of the outer rotor. However, if the rotors are rotated separately by dedicated motors the speeds of the rotors can be adjusted as needed. During counting of the pills, the speeds of the rotors can be different for different rotors. During the returning of the remaining pills, the speed(s) of the inner rotor(s) can be brought up to the speed of the outermost rotor, maximizing the overall throughput of the machine.

In a flat or planar rotor configuration, pills move preferably along a smooth spiral path. However, a conical or convex rotor configuration desirably defines a stepped spiral path. This latter geometry facilitates tumbling of the pills and therefore forces them to separate if they become stacked. Further, the rotors can be shaped with steps providing additional tumbling action.

More specifically the invention is a pill dispensing machine comprising: a cassette including a first rotor disposed for rotation about a rotation axis, a second rotor disposed for rotation about the first rotor and the rotation axis, and a discharge chute or opening; at least one motor for rotating the first rotor at a first speed and for rotating the second rotor at a second, faster speed; and one or more plates spaced from the first and second rotors and defining therewith a spiral path that extends between a first location at or adjacent the rotation axis and a second location at or adjacent the discharge chute.

The pill dispensing machine can further include means for counting pills exiting the discharge chute or opening. The means for counting can include: a substantially spatially coherent light source and a photodiode positioned on opposite sides of a pill pathway; a collimating lens for collimating light output by the light source and for passing the collimated light to the pill pathway; a focusing lens for focusing light exiting the pill pathway onto the photodiode; and a controller programmed to be responsive to changes in an amount of the focused light received by the photodiode in response to the passage of pills through the collimated light in the pill pathway for accumulating a count of pills that pass through the collimated light in the pill pathway.

The pill dispensing machine can further include: the first rotor having a first density of radial grooves, indentation or protrusions; and the second rotor having a second density of radial grooves, indentations, or protrusions.

The pill dispensing machine can further include each rotor having a conical or convex pill receiving surface that slopes downward in the direction of the discharge chute or opening with greater radial distance from the rotation axis. The pill dispensing machine can further include a step between the conical or convex pill receiving surface of the first rotor and the conical or convex pill receiving surface of the second rotor.

The one or more plates can include a plurality of plates arranged such that the spiral path is a stepped spiral path.

The pill dispensing machine can further include each rotor having a pill receiving surface that is sloped.

The pill dispensing machine can further include a feed chute disposed for feeding pills on the first rotor at the first location of the spiral path.

The invention is also a pill dispensing machine comprising: a plurality of concentric rotors having pill receiving surfaces; at least one motor for rotating the plurality of concentric rotors at different rotational speeds about a rotation axis; and at least one plate spaced from the pill receiving surfaces of the plurality of concentric rotors and defining with said pill receiving surfaces all or part of a spiral path which extends between the innermost rotor and the outermost rotor.

The pill dispensing machine can further include: a discharge chute or opening adjacent the outermost rotor from the rotation axis; and means for counting pills exiting the discharge chute or opening. The means for counting can include: a laser light source and a photodiode positioned on opposite sides of a pill pathway; a collimating lens for collimating light output by the laser light source and for passing the collimated light to the pill pathway; a focusing lens for focusing light exiting the pill pathway onto the photodiode; and a controller responsive to changes in an amount of the focused light

received by the photodiode due to the passage of pills through the collimated light in the pill pathway for accumulating a count of pills that pass through the collimated light in the pill pathway.

The pill dispensing machine can further include each rotor having radial grooves, indentations, or protrusions.

The pill dispensing machine can further include each rotor having a different number and/or density of radial grooves, indentations, or protrusions, with each outer rotor having a different number and/or density of radial grooves, indentations, or protrusions than each inner rotor.

The pill dispensing machine can further include the plurality of concentric rotors defining conical or convex pill receiving surfaces that slope downward with greater radial distance from the rotation axis.

The pill dispensing machine can further include a step between each pair of conical or convex pill receiving surfaces.

The pill dispensing machine can include a plurality of plates arranged such that the spiral path is a stepped spiral path.

The pill dispensing machine can further include a feed chute disposed for feeding pills to the rotor radially closest to the rotation axis.

The pill receiving surface of at least one rotor can slope upwardly, downwardly, or both upwardly and downwardly at different points radially from the rotation axis.

Lastly, the invention is a method of pill dispensing comprising: step (a) a first rotor rotating pills about a rotation axis along a first part of a spiral path at a first rotational speed whereupon the pills move spirally away from the rotation axis; and step (b) a second rotor receiving the pills from the first rotor and rotating the pills about the rotation axis along a second part of the spiral path at a second, greater rotational speed whereupon the pills move spirally away from the rotation axis.

The method can further include: step (c), following step (b), feeding the pills to a discharge chute or opening; and step (d), following step (c), accumulating a count of pills that pass through a beam of collimated light.

The method can further include the first and second rotors having pill receiving surfaces that are shaped whereupon the pills also move parallel with the rotation axis (up, down, or both up and down) concurrent with the first and second rotors moving the pills spirally away from the rotation axis.

The method can further include: feeding the pills to the first rotor; and following step (b), feeding the pills to a discharge chute or opening.

The spiral path can be a stepped spiral path whereupon the pills move in a stepped spiral away from the rotation axis.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a pill dispensing machine that includes in the interior thereof a cassette that is operative for separating pills into a single line or queue;

FIG. **2** is a partially open perspective view of a first embodiment cassette that can be utilized with the pill dispensing machine shown in FIG. **1** in operative relation to a block diagram of operationally related components of the pill dispensing machine;

FIG. **3** is an isolated perspective view of the base and two rotors of the first embodiment cassette shown in FIG. **2**;

FIG. **4**A is a perspective view of a second embodiment cassette that can be utilized with the pill dispensing machine of FIG. **1** in operative relation to a chute and hopper utilized to feed pills to the second embodiment cassette all in operative relation to a block diagram of operationally related components of the pill dispensing machine;

FIG. **4**B is an isolated perspective view of the rotors and arcuate plate(s) of the second embodiment cassette of FIG. **4**A that, in combination, form a stepped spiral pill path;

FIG. **5** is a cross section of the second embodiment cassette taken along lines V-V in FIG. **4**A;

FIG. **6** is a partially open cross-sectional perspective view of a third embodiment cassette that can be utilized with a pill dispensing machine of FIG. **1** in operative relation to a block diagram of the operationally related components of the pill dispensing machine;

FIG. **7** is a modified version of the second embodiment cassette shown in FIGS. **2** and **3**; and

FIG. **8** is a schematic drawing of an embodiment detector for detecting each pill that passes therethrough;

DETAILED DESCRIPTION OF THE INVENTION

The present invention will now be described with reference to the accompanying figures where like reference numbers correspond to like elements.

With reference to FIG. **1**, a pill dispensing machine **2** includes a housing **4** having an opening **6** in a top side of housing **4** for feeding pills (not shown) to a chute **8**, either directly or via a hopper **9** (FIG. **4**A), for processing and counting by pill dispensing machine **2** in a manner described hereinafter and for deposit of the counted pills into a pill bottle **10**. Pills in excess of a desired number of pills to be dispensed into pill bottle **10** can be dispensed to a storage container **12**.

With reference to FIGS. **2** and **3** and with continuing reference to FIG. **1**, pill dispensing machine **2** can include first embodiment cassette **14**. In FIG. **2**, a section of cassette **14** is shown removed for the purposes of illustration.

Cassette **14** includes a first rotor **16** disposed about a rotation axis **18** and a second rotor **20** disposed about first rotor **16** and rotation axis **18**. As shown in FIG. **3**, first rotor **16** and second rotor **20** are concentric about rotation axis **18**.

First rotor **16** and second rotor **20** can be independently rotated about the rotation axis via one or more motors **22**. To this end, each rotor **16** and **20** can be rotated separately by dedicated motors, the speeds of which can be adjusted as needed. Alternatively, rotors **16** and **20** can be rotated by a single motor through a set of fixed gears. In the illustrated embodiment, rotors **16** and **20** are rotated in the direction shown by arrow **24**. However, this is not to be construed as limiting the invention.

Cassette **14** includes a spiral plate **26** disposed in spaced relation over the pill receiving (or top) surfaces of first and second rotors **16** and **20**. Spiral plate **26** is held in spaced relation to first and second rotors **16** and **20** by a cover **25** of cassette **14**. The combination of spiral plate **26** and the pill receiving surfaces of first and second rotor(s) **16** and **20** define a spiral path **28** that extends between an opening **15** of cassette **14** adjacent rotation axis **18** and a discharge chute **30** of cassette **14** adjacent the periphery of second rotor **20**.

Pill dispensing machine **2** desirably includes an adjustable gate **32** and a detector **34** coupled to a controller **36** which can optionally be coupled to control the one or more motors **22** and, hence, the rotation of first rotor **16** and second rotor **20**. Desirably, adjustable gate **32** is controlled by controller **36** to direct pills exiting discharge chute **30** to either pill bottle **10** or storage container **12**.

Detector **34** can be any suitable and/or desirable type or form of detector, for example, without limitation, a photodetector, which is capable of detecting when a pill enters pill

bottle **10**. Detector **34** provides an indication of each pill entering the pill bottle **10** to controller **36** which can, for each pill bottle **10**, accumulate a count of the number of pills entering pill bottle **10**. Optionally, another detector **35**, like detector **34**, can be provided between discharge chute **30** and adjustable gate **32** to provide to controller **36** an indication of each pill exiting discharge chute **30**. Controller **36** can be programmed to compare the count of pills entering pill bottle **10** provided by detector **34** to the count of pills detected by detector **35** to ensure the accuracy of the count of the number of pills in pill bottle **10**. The use of detectors **34** and **35** helps avoid the situation where one detector counts two pills as a single pill but the other detector counts each pill of the two pills separately.

At a suitable time, when a desired number of pills have been dispensed into pill bottle **10**, controller can activate adjustable gate **32** to redirect any remaining pills exiting discharge chute **30** to storage container **12**. Controller **36** can take the difference between the number of pills counted by detector **35** and the number of pills counted by detector **34** as an indication of the number of pills introduced into storage container **12** after adjustable gate **32** has been set to direct pills exiting discharge chute **30** to storage container **12**.

Controller **36** can include a suitable human machine interface (HMI) **38** that enables a user of pill dispensing machine **2** to enter a desired number of pills to be dispensed into pill bottle **10**. Following the entry by a user into HMI **38** of the desired number of pills to be dispensed into pill bottle **10**, the one or more motors **22** can be activated (either manually or via controller **36**) to commence rotation of first and second rotors **16** and **20**. Thereafter, in response to the introduction of pills into opening **15** via chute **8**, pills are rotated by first and second rotors **16** and **20** in the direction of arrow **24** within the spiral path **28** defined by spiral plate **26** and first and second rotors **16** and **20**. In operation, the one or more motors **22** cause first rotor **16** to rotate at a first speed and cause second rotor **20** to rotate at a second, faster speed. Rotating second rotor **20** at a faster speed than first rotor **16** facilitates the separation of pills into a single line or queue and the feeding of the separated pills to discharge chute **30**.

Under the control of controller **36**, the position of adjustable gate **32** can be controlled to fill pill bottle **10** with the desired number of pills programmed into controller **36** via HMI **38**. Detector **34**, detector **35**, or both enable controller **36** to keep an accurate count of the pills entering pill bottle **10** whereupon, in response to controller **36** determining that the number of pills dispensed into pill bottle **10** equals the desired number of pills to be introduced into pill bottle **10** programmed into controller **36** via HMI **38**, controller **36** causes adjustable gate **32** to assume a position (shown in phantom in FIG. **2**) whereupon any further pills exiting discharge chute **30** will be directed to storage container **12**.

The one or more motors **22** can continue operation for a suitable and/or desirable period of time after filling pill bottle **10** with the desired number of pills to ensure that all of the pills introduced into cassette **14** have exited discharge chute **30**.

Optionally, first rotor **16** can have a first number and density of radial grooves, indentations, or protrusions **40** and second rotor **20** can have a second, greater number and/or density of radial grooves, indentations, or protrusions **42**. These radial grooves, indentations, or protrusions **40** and **42** avoid round pills from rolling thereby facilitating fast and well-controlled movements of the pills. It is to be appreciated, however, that grooves, indentations, or protrusions **40** and/or **42** are optional.

With reference to FIGS. **4**A, **4**B, and **5** and with continuing reference to FIGS. **1-3**, a second embodiment cassette **54** that can be utilized with pill dispensing machine **2** in replacement of the first embodiment cassette **14** discussed above includes an opening **55** for receiving pills from chute **8**. Cassette **54** includes three rotors **56**, **58**, and **60** disposed concentrically about a rotation axis **62**. Under the control of the one or more motors **22**, the third, outermost rotor **60** is rotated faster than second, intermediate rotor **58** which, in-turn, is rotated faster than first, innermost rotor **56**.

Cassette **54** also includes a plurality of arcuate plates **64-1**-**64-4** fixedly supported in spaced relation over rotors **56**, **58**, and **60** by braces **65** (FIG. **4**A). The combination of arcuate plates **64-1-64-4** and rotors **56**, **58**, and **60** define a stepped spiral path **66** that extends between a point adjacent rotation axis **62**, e.g., at opening **55**, and a discharge opening **68** of cassette **54**.

In operation, cassette **54** can replace cassette **14** in pill dispensing machine **2** with discharge opening **68** positioned to dispense pills to adjustable gate **32**. Pill dispensing machine **2** can include suitable mechanical guides (not shown) that can be utilized to guide pills dispensed from discharge chute **30** of cassette **14** or discharge opening **68** of cassette **54** to adjustable gate **32**. Hence, the location of discharge opening **68** in the center of a wall of cassette **54** and the location of discharge chute **30** in a corner of cassette **14** are not to be construed as limiting the invention.

As shown in FIGS. **4**A, **4**B, and **5**, the pill receiving (top) surfaces of rotors **56**, **58**, and **60** desirably define conical or convex surfaces that slope downward from opening **55** with greater radial distance from rotation axis **62**. Optionally, rotors **56**, **58**, and **60** can be configured to define a step **70** between first rotor **56** and second rotor **58** and a step **72** between second rotor **58** and third rotor **60**.

It is believed that the combination of steps **70** and **72** and the conical or convex pill receiving surfaces of rotors **56**, **58**, and **60** enhance the capability of cassette **54** to separate pills into a single line or queue for delivery to discharge opening **68**.

Desirably, cassette **54** and cassette **14** are interchangeable in pill dispensing machine **2** without affecting the operation of pill dispensing machine **2**.

Optionally, rotors **56**, **58**, and **60** include radial grooves, indentations, or protrusions **74**, **76**, and **78**, respectively, that avoid pills from rolling and therefore facilitate fast and well-controlled movement of the pills. Desirably, the number and/or density of radial grooves, indentations, or protrusions **78** of third rotor **60** is greater than the number and/or density of radial grooves, indentations, or protrusions **76** of second rotor **58** which is greater than the number and/or density of radial grooves, indentations, or protrusions **74** of first rotor **56**.

In the embodiment of cassette **54** shown in FIGS. **4**A, **4**B, and **5**, the combination of arcuate plates **64-1-64-1** and the stepped conical surfaces of rotors **56**, **58**, and **60** and steps **70** and **72** define the steps **80** of stepped spiral path **66**. Stepped spiral path **66** facilitates tumbling and separation of pills traveling therealong.

In operation of cassette **54**, first rotor **56** rotates pills along a first part of stepped spiral path **66** at a first rotational speed whereupon the pills move stepped spirally and radially away from rotation axis **62**. Second rotor **58** receives the pills from first rotor **56** and rotates the pills about rotation axis **62** along a second part of stepped spiral path **66** at a second, greater rotational speed whereupon the pills move stepped spirally and radially away from rotation axis **62**. Third rotor **60** receives pills from second rotor **58** and rotates the pills about rotation axis **62** at a third, greater rotational speed than the

second rotational speed for discharge from cassette **54** via discharge chute **68**. Because of the conical surfaces of rotors **56**, **58**, and **60**, pills traveling along stepped spiral path **66** in response to rotation of rotors **56**, **58**, and **60** will also move vertically (downward) in a direction parallel with rotation axis **62** concurrent with movement of the pills stepped spirally and/or radially away from rotation axis **62**.

With reference to FIG. **6** and with continuing reference to FIGS. **1-5**, a third embodiment cassette **82** that can be utilized with pill dispensing machine **2** in replacement of cassette **14** (FIGS. **2** and **3**) and/or cassette **54** (FIGS. **4**A, **4**B, and **5**) includes an opening **83** for feeding pills via chute **8** to a first rotor **84** disposed for rotation about a rotation axis **88** and a second rotor **86** disposed concentrically with first rotor **84** for rotation about first rotor **84** and rotation axis **88**. As shown in FIG. **6**, the pill receiving surface of first rotor **84** is generally flat adjacent rotation axis **88** and slopes upwardly with greater radially distance from rotation axis **88**. The pill receiving surface of second rotor **86** initially slopes downward and then upward with greater radial distance from rotation axis **88**. Desirably, the outside radius of rotor **84** and the inside radius of rotor **86** are at substantially the same height. However, this is not to be construed as limiting the invention. Desirably, under the control of one or more motors **22**, first rotor **84** can be rotated at a first rotational speed and second rotor **86** can be rotated at a second, greater rotational speed.

Cassette **82** includes a spiral plate **90** supported in spaced relation over first and second rotors **84** and **86** by a cover **91** of cassette **82**. The combination of spiral plate and first and second rotors **84** and **86** define a spiral path **92** that extends between a point adjacent rotation axis **88** and a discharge chute **94** of cassette **82**.

Desirably, the edge of spiral plate **90** that is positioned in spaced facing relation with the pill receiving surfaces of first and second rotors **84** and **86** is shaped to track or follow the shapes/slopes of the pill receiving surfaces of first and second rotors **84** and **86**.

Optionally, first rotor **84** includes radial grooves, indentations, or protrusions **96** and second rotor **86** includes radial grooves, indentations, or protrusions **98**. Desirably, first rotor **84** includes a first number and/or density of radial grooves, indentations, or protrusions **96** and second rotor **86** includes a second, greater number and/or density of radial grooves, indentations, or protrusions **98**. Radial grooves, indentations, or protrusions **96** and **98** avoid pills from rolling on the pill receiving surfaces of first and second rotors **84** and **86** during transport of the pills along spiral path **92** to discharge chute **94**.

In operation of cassette **82**, under the control of one or more motor(s) **22**, first rotor **84** rotates pills entering opening **83** about rotation axis **88** along a first part of spiral path **92** at a first rotational speed whereupon the pills move spirally and radially away from rotation axis **88**. Second rotor **86** receives the pills from first rotor **84** and rotates the pills about rotation axis **88** along a second part of spiral path **92** at a second, greater rotational speed, whereupon the pills move spirally and radially away from rotation axis **88**. Because of the sloped surfaces of first and second rotors **84** and **86**, pills moving along spiral path **92** away from rotation axis **88** will also move in a direction parallel with rotation axis **88**, i.e., in an up direction and a down direction, concurrent with the first and second rotors **84** and **86** moving the pills radially away from rotation axis **88** along spiral path **92**.

With reference to FIG. **7** and with reference back to FIGS. **2** and **3**, a variation of the first embodiment cassette **14** (FIGS. **2** and **3**) is shown in FIG. **7** as cassette **14-1**. Cassette **14-1** includes a first rotor **16-1** disposed for rotation about a rotation axis **18-1**, a second rotor **20-1** disposed for rotation about first rotor **16-1** and rotation axis **18-1**, and third rotor **100** disposed for rotation about second rotor **20-1** and rotation axis **18-1**. Cassette **14-1** includes a spiral plate **26-1** that is held in spaced facing relation to rotors **16-1**, **20-1**, and **100** via a cover (not shown) of cassette **14-1**. The combination of spiral plate **26-1** and rotors **16-1**, **20-1**, and **100** define a spiral path **28-1** that extends between a first location at or adjacent rotation axis **18-1** and a second location at or adjacent a discharge port **30-1** of cassette **14-1**.

Under the control of one or more motors **22**, rotor **16-1** is rotated at a first rotational speed, rotor **20-1** is rotated at a second, greater rotational speed, and rotor **100** is rotated at a third rotational speed that is greater than the rotational speed of rotor **20-1**. In response to rotation of rotors **16-1**, **20-1** and **100** in this manner, pills introduced onto rotor **16-1** at or adjacent rotation axis **18-1** travel along spiral path **26-1** from a position adjacent rotation axis **18-1** to discharge chute **30-1**. Essentially, the difference between cassette **14** (FIGS. **2** and **3**) and cassette **14-1** (FIG. **7**) is the addition of third rotor **100**. Operationally cassette **14-1** can be used in replacement of any one of cassette **14**, cassette **54** or cassette **82** in pill dispensing machine **2**.

As can be seen from the foregoing, the pill dispensing machine (FIG. **1**) can utilize the first embodiment cassette **14** (FIGS. **2** and **3**), the second embodiment cassette **54** (FIGS. **4** and **5**), the third embodiment cassette **82** (FIG. **6**), or the alternate first embodiment cassette **14-1** (FIG. **7**) to separate pills into a single line or queue that can be dispensed into a pill bottle **10** via adjustable gate **32**, detector **34** and, if provided, optional detector **35** which provide(s) to controller **36** a count of pills entering pill bottle **10**. Detector **35** provides to controller **36** an indication of each pill entering adjustable gate **32**. Under the control of controller **36**, adjustable gate **32** can be set to permit pills to enter pill bottle **10**. Each pill entering pill bottle **10** is detected by detector **34** which supplies an indication thereof to controller **36** which maintains an aggregate count of pills entering pill bottle **10**. At a suitable time after the number of pills dispensed into pill bottle **10** equals a desired number of pills to be dispensed into pill bottle **10**, controller **36** causes adjustable gate **32** to redirect pills being discharged from the cassette to storage container **12**. During the dispensing of pills, controller can utilize the count of pills detected by detectors **34** and **35** to confirm that the desired number of pills is dispensed into pill bottle **10**. Once the desired number of pills have been dispensed into pill bottle **10** and adjustable gate **32** has been set to redirect pills into storage container **12**, controller **36** can take the difference in the counts of pills detected by counter **35** after and during the filling of pill bottle **10** and the count detected by detector **34** during the filling of pill bottle **10** to obtain a count of the number of pills introduced into storage container **12**.

The rotational speeds of the rotors of each embodiment cassette **14**, **54**, **82**, and **14-1** can be controlled by one or more motors **22** operating independently (manually) or under the control of controller **36**. The plurality of rotors of each cassette **14**, **54**, **82**, and **14-1** can be rotated by a single motor through a set of fixed gears. Also or alternatively, each rotor of each cassette **14**, **54**, **82**, and **14-1** can be rotated separately by a dedicated motor. In each embodiment cassette **14**, **54**, **82**, and **14-1** outer rotors further away from the corresponding rotation axis are rotated faster than inner rotors thereby providing an effective way to separate pills into a single line or queue.

With reference to FIG. **8**, the combination of controller **36**, and detector **34**, detector **35**, or both detectors **34** and **35**, define a means for counting pills that exit discharge chute or

opening **30**, **68**, **94**, or **30-1**. In this regard, detector **34**, detector **35**, or both, are part of pill dispensing machine **2** and can be utilized with any embodiment cassette **14**, **54**, **82**, or **14-1** described above.

The preferred embodiment detector shown in FIG. **8**, which can be utilized as detector **34**, detector **35**, or both, includes a light source **100'**, e.g., without limitation, a substantially spatially coherent light source, and a photodiode **102** positioned on opposite sides of a pill pathway **104** configured for the passage of one or more pills **106** that exit discharge chute/opening **30**, **68**, **94**, or **30-1**. Light source **100'** can be a laser light source, such as a laser diode, an LED, or any other suitable and/or desirable substantially spatially coherent light source, or the combination of a light source and optical elements that can act as a substantially spatially coherent light source. Pill pathway **104** can be defined by one or more walls **128** and can be of any suitable and/or desirable length and/or geometry, such as, without limitation, cylindrical shaped.

A beam of light **108** output by light source **100'** is converted by a first focusing cylindrical lens **110** and a collimating lens **112** into a beam of collimated light **114** that enters pill pathway **104** via openings **130** in walls **128** after exiting collimating lens **112**.

After passage through pill pathway **104** and any pills **106** in the path of the beam of collimated light **114**, said beam of collimated light **114** is focused onto photodiode **102** by a second focusing cylindrical lens **116**. In an embodiment, photodiode can optionally include a pinhole aperture **118** to avoid light other than light coming from second focusing cylindrical lens **116** from impinging on photodiode **102**. The use of pinhole aperture **118**, however, is optional and is not to be construed in a limiting sense.

Optionally, windows **120** and **122** can be provided over openings **130** in the pathway of the beam of collimated light **114** on opposite sides of pill pathway **104** to avoid dust associated with pills **106** from entering and obscuring light source **100'**, photodiode **102**, and/or one or more of lenses **110**, **112**, and **116**. Each window **120** and **122** can be made of glass or similar transparent material that facilitates the distortion free passage of the beam of collimated light **114** therethrough. Alternatively, windows **120** and **122** can be omitted (whereupon openings **130** are uncovered) and replaced by a positive air pressure source **124** and associated ductwork **126** to supply air under positive pressure to openings **130**. The pressurized air passing through openings **130** avoids dust from entering and obscuring light source **100'**, photodiode **102**, and/or one or more of lenses **110**, **112**, and **116**.

The use of the embodiment detector shown in FIG. **8** as a spatial filter to facilitate the counting of pills **106** passing along pill pathway **104** will now be described.

In the absence of a pill **106** passing through the beam of collimated light **114**, second focusing cylindrical lens **116** focuses the beam of collimated light **114** onto photodiode **102**. In response to a pill **106** passing through the beam of collimated light **114** in pill pathway **104**, the amount of light that reaches photodiode **102** momentarily changes, i.e., decreases. This momentary change in the amount of light reaching photodiode **102** results in a decrease in current output by photodiode **102**, which decrease in output current is sensed by controller **34** in a manner known in the art over the amount of current output by photodiode **102** in response to no pill **106** passing through the beam of collimated light **114** in pill pathway **104**.

More specifically, in response to a pill **106** passing through the beam of collimated light **114** in pill pathway **104**, the amount of light that reaches photodiode **102** momentarily changes, i.e., decreases. In the case of an opaque pill part of the beam power is blocked or absorbed by the pill. In the case of a transparent pill such as fish oil capsule the light passing though the pill is distorted changing its direction of propagation. Optical filtering blocks this redirected part of the beam from entering the aperture of the photodiode resulting in reduced intensity of the received beam that can be detected by the processing circuitry. This approach allows reliable detection of pills regardless of their transparency.

Controller **36** can be programmed to accumulate a count of each decrease in a predetermined amount of current output by photodiode **102** in response to a pill **106** passing through the beam of collimated light **114** in pill pathway **104** as a count of the total number of pills **106** passing through the detector shown in FIG. **8**.

When an instance of the detector shown in FIG. **8** is utilized as detector **34**, controller **36** can accumulate a count of pills **106** dispensed into pill bottle **10**. When an instance of the detector shown in FIG. **8** is utilized as detector **35** in combination with detector **34**, an accumulated count of the total number of pills being dispensed from discharge chute/opening **30**, **68**, **94**, or **30-1** and detected by detector **35** can be subtracted from the accumulated count of pills detected by detector **34** (dispensed into pill bottle **10**) to determine the total number of pills dispensed into storage container **12**. Detectors **34** and **35** can also or alternatively be used in series to confirm the number of pills dispensed directly into pill bottle **10**.

It is envisioned that pill counter **2** can include another gate (not shown) in the form of a mechanical shutter located between discharge chute/opening **30**, **68**, **94**, or **30-1** and adjustable gate **32**. This other gate can be closed during movement of adjustable gate **32** from dispensing pills into pill bottle **10** to dispense pills to storage container **12** to avoid pills from entering adjustable gate **32** during said movement and inadvertently being dispensed into pill bottle **10**.

Where the dispensing of pills into chute **8** via hopper **9** (FIGS. **4A**, **5** and **6**) is controlled by controller **36**, the speed at which pills are dispensed into chute **8** by hopper **9** can be controlled by controller **36** in response to detecting pills on the innermost rotor. For example, when pills are detected [via a suitable sensor (not shown), such as, without limitation, a photodetector] on the innermost rotor, controller **36** can slow down or stop the dispensing of pills into chute **8** thereby avoiding pills from piling up and overwhelming the counting system.

The speed of the outermost rotor can also be controlled by controller **36** according to the output of a suitable sensor (not shown), such as, without limitation, a photodetector. When a pill is detected on the outermost rotor near the edge of the discharge chute or opening by the sensor, the rotation of the outermost rotor can be slowed by controller **36** to avoid pills from overwhelming detector **34**, detector **35**, or both.

Lastly, the sensor detecting the presence of a pill near the edge of the discharge chute or opening can also or alternatively be utilized to measure the size of the counted pills. Based on this size, the overall speed of the rotors can be adjusted for optimum speed and counting accuracy. This sensor can also or alternatively be replaced by an imaging sensor, such as a video chip and image recognition associated with controller **36** to permit faster and more accurate speed control.

This invention has been described with reference to exemplary embodiments. Obvious modifications and alterations will occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be

construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

The invention claimed is:

1. A pill dispensing machine comprising:

a cassette including a first rotor disposed for rotation about a rotation axis, a second rotor disposed for rotation about the first rotor and the rotation axis, and a discharge chute or opening;

at least one motor for rotating the first rotor at a first speed and for rotating the second rotor at a second, faster speed;

one or more plates spaced from the first and second rotors and defining therewith a spiral path at least partially about the rotation axis that extends between a first location at or adjacent the rotation axis and a second location at or adjacent the discharge chute; and

means for counting pills that exit the discharge chute comprising:

a light source and a photodiode positioned on opposite sides of a pill pathway;

a collimating lens for collimating light output by the light source and for passing the collimated light to the pill pathway;

a focusing lens for focusing light exiting the pill pathway onto the photodiode; and

a controller programmed to be responsive to changes in an amount of the focused light received by the photodiode in response to the passage of pills through the collimated light in the pill pathway for accumulating a count of pills that pass through the collimated light in the pill pathway.

2. The pill dispensing machine of claim **1**, further including:

the first rotor having a first density of radial grooves, indentation or protrusions; and

the second rotor having a second, greater density of radial grooves, indentations, or protrusions.

3. The pill dispensing machine of claim **1**, further including:

the first rotor having a conical or convex pill receiving surface that slopes downward in the direction of the discharge chute or opening with greater radial distance from the rotation axis; and

the second rotor having a conical or convex pill receiving surface that slopes downward in the direction of the discharge chute or opening with greater radial distance from the first rotor.

4. The pill dispensing machine of claim **3**, further including a step between the conical or convex pill receiving surface of the first rotor and the conical or convex pill receiving surface of the second rotor.

5. The pill dispensing machine of claim **1**, wherein the one or more plates include a plurality of plates arranged such that the spiral path is a stepped spiral path.

6. The pill dispensing machine of claim **1**, further including:

the first rotor having a pill receiving surface that includes a slope; and

the second rotor having a concave pill receiving surface that includes a slope.

7. A pill dispensing machine comprising:

a plurality of concentric rotors having pill receiving surfaces;

at least one motor for rotating the plurality of concentric rotors at different rotational speeds about a rotation axis;

at least one plate spaced from the pill receiving surfaces of the plurality of concentric rotors and defining with said pill receiving surfaces all or part of a spiral path at least partially around the rotation axis which extends between the innermost rotor and the outermost rotor;

a discharge chute or opening adjacent the outermost rotor from the rotation axis; and

means for counting pills that exit the discharge chute or opening, said means for counting including:

a light source and a photodiode positioned on opposite sides of a pill pathway;

a collimating lens for collimating light output by the light source and for passing the collimated light to the pill pathway;

a focusing lens for focusing light exiting the pill pathway onto the photodiode; and

a controller responsive to changes in an amount of the focused light received by the photodiode due to the passage of pills through the collimated light in the pill pathway for accumulating a count of pills that pass through the collimated light in the pill pathway.

8. The pill dispensing machine of claim **7**, further including each rotor having radial grooves, indentations, or protrusions.

9. The pill dispensing machine of claim **7**, further including each rotor having a different number and/or density of radial grooves, indentations, or protrusions, with each outer rotor having a different number and/or density of radial grooves, indentations, or protrusions than each inner rotor.

10. The pill dispensing machine of claim **7**, further including the plurality of concentric rotors defining conical or convex pill receiving surfaces that slope downward with greater radial distance from the rotation axis.

11. The pill dispensing machine of claim **10**, further including a step between each pair of conical or convex pill receiving surfaces.

12. The pill dispensing machine of claim **7**, wherein the pill dispensing machine includes a plurality of plates arranged such that the spiral path is a stepped spiral path.

13. The pill dispensing machine of claim **7**, further including a feed chute disposed for feeding pills to the rotor radially closest to the rotation axis.

14. The pill dispensing machine of claim **7**, the pill receiving surface of at least one rotor slopes upwardly, downwardly, or both upwardly and downwardly at different points radially from the rotation axis.

15. A method of pill dispensing comprising:

(a) a first rotor rotating pills about a rotation axis along a first part of a spiral path at least partially around the rotation axis at a first rotational speed whereupon the pills move spirally away from the rotation axis;

(b) a second rotor receiving the pills from the first rotor and rotating the pills about the rotation axis along a second part of the spiral path at least partially around the rotation axis at a second, greater rotational speed whereupon the pills move spirally away from the rotation axis;

(c) following step (b), feeding the pills to a discharge chute or opening; and

(d) following step (c), accumulating a count of pills that pass through a beam of collimated light after exiting the discharge chute or opening.

16. The method of claim **15**, further including the first and second rotors having pill receiving surfaces that are shaped whereupon the pills move parallel with the rotation axis concurrent with the first and second rotors moving the pills spirally away from the rotation axis.

17. The method of claim 15, wherein the spiral path is a stepped spiral path whereupon the pills move in a stepped spiral away from the rotation axis.

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